

INTRODUCTION

The Marine Corps Recruit Depot, Parris Island (MCRD PI or the Depot), South Carolina (SC), is a vital asset to the nation's national security. "We Make Marines" at Parris Island. This is our mission and we have been training Marine recruits at the Depot since 1915. With the increased potential of climate change impacting the Depot's mission in the near future, the Environmental Division recognized that identifying potential resiliency adaptations required multi-disciplinary expertise beyond the organic environmental program capabilities of the Depot. In response to this need, a Climate Change Adaptation and Resiliency (CCAR) Team was formed consisting of the Depot, Naval Facilities Engineering Command (NAVFAC), and contractors. This multi-disciplinary team consisted of the following stakeholders; Depot representatives included physical scientists, asset managers, and active duty Marines; the Navy provided coordination and task management; contractors and sub-contractors analyzed and interpreted data, produced models and compiled all meeting and stakeholder input into the final product.

The CCAR Team was faced with ensuring the Depot could continue the successful transformation of recruits into Marines in the face of dynamic climate change scenarios. The Depot located in Beaufort, SC, consists of a system of islands, salt marshes, saltwater creeks, and tidal ponds between the Beaufort and Broad Rivers. The average elevation in this area is only 5 feet above sea level and most of MCRD PI is within the 100-year flood plain. With only 8,000 acres, approximately half of which is unusable marshland, potential climate change scenarios threaten our mission in numerous ways. Storm surge events from increased extreme weather events causes localized flooding in areas of key infrastructure and training operations. This impacts critical infrastructure that includes the singular access causeway to the island, training ranges, recruit/family housing, administrative/community facilities, and all utilities that support them. Additionally, high temperature days are negatively impacting training by increasing the frequency of "black flag" events that reduce permissible trainings. As one of only two Marine Corps Recruit Depots, it was vital that the CCAR Team methodically address these risks to mission.

The CCAR Team based its efforts on the "Climate Change Installation Adaptation and Resilience Planning Handbook" (the Handbook) published in January 2017 by NAVFAC. It provided an analytical framework and methodology to assist installations in incorporating climate change factors in their plans and projects. MCRD PI is the first Department of Defense (DoD) installation to implement the Handbook. The personnel that made up the CCAR Team are as follows:

NAVFAC

- Susan Lang, NAVFAC Mid-Atlantic/Marine Corps Planning Team, Task Order Manager
- Dave James, NAVFAC Atlantic/Marine Resources Branch Manager, Advisor

MCRD Parris Island, G-4 Team

Environmental Division:

- Tracey Spencer, EV Restoration Mgr. **POC**
- John Holloway, Natural Resource Mgr.
- Tim Harrington, Dir, EV Division (Ret)
- Capt. Brandon Barnes, Deputy Dir EV Div

- Maj. Marc Blair, Director EV Division

Asset Management Division:

- Derek Findlay Supervisor, Asset Management Division/Acting Planner

Public Works Department:

- CDR Andrew Litteral, Public Works Officer

Contractor Team

Leidos: Christina Hudson, Senior Project Manager

WSP: Carolyn Mitchell, Resiliency Planning Lead

Versar: John Ouellette, VP Environmental Services Group

TEAM BACKGROUND AND MISSION

The CCAR Team produced a comprehensive project portfolio and complete set of Handbook Worksheets incorporating natural infrastructure management (including green infrastructure and enhanced natural buffers), reduction of water and energy use, and master planning. The portfolio provides a guide for the Depot to address climate-impacts to the mission in the short, mid, and long-term for current predicted storm surges, as well as future sea level rise (2035, 2065 and 2100). The overall objective of this project is supporting the long-term operational sustainability of the mission of MCRD PI while protecting human health, installation property, and the environment. Each component of the team was integral to the process and the interdisciplinary team contributed in the following ways:

- ***NAVFAC*** authored the coordinated strategy for integration of CCAR projects into the 2020 Master Plan Update. NAVFAC coordinated the contractors' and installation's work and included additional stakeholders in Workshops who provided specific expertise relevant to adaptation alternatives, such as the **NAVFAC Design Managers, and AE firms, for active Rifle Range projects scheduled for the next several years**. The **NAVFAC ML Sea Level Rise SME, a Civil Engineer and Landscape Architect**, provided technical input. Additional stakeholders that NAVFAC integrated into the Workshops included a Marine Corps Installations Command (MCICOM) Planning Representative who provided an enterprise-wide perspective and a Marine Corps Air Station Beaufort representative who provided a regional perspective.
- ***The MCRD Parris Island Team*** actively participated in the stakeholder meetings and continued to **provide follow-up information** as needed. Document and process reviews allowed for critical adjustments in how we implemented the final solutions to best fit the Depot's needs. During one review, the MCRD Parris Island Team identified the need to combine action alternatives to address one impacted area thus **preserving mission essential training facilities**. This out of the box thinking required reorganization of the project midstream, but the contracting team quickly adjusted and adapted to provide a product superior to the original proposal. Early in the assessment, the CCAR Team realized that encouraging the participation of all Depot stakeholders in Workshops would provide better data and assessment of environmental changes and their mission impacts. Representatives from the **Lowcountry Council of Governments** (local community

representatives), MCRD PI Legal, **Weapons and Training Battalion**, Marine Corps Community Services, G4, G3, G6, and military housing residence also engaged during Stakeholder Workshops. While not part of the formal team, these stakeholders provided invaluable knowledge and perspectives that would have left the project lacking without their input.

- **The LEIDOS Team** coordinated the two subcontractors, WSP and Versar, and provided input on climate change policy. They led the first stakeholder meeting and provided expertise on the Handbook process.
- **The WSP Team** led the second Stakeholder Workshop. WSP assessed and refined adaptation alternatives defined by the installation and prepared the Economic Analysis in the form of a Benefit Cost Analysis.
- **The Versar Team** produced the GIS model of Sea Level Rise and Storm Surge for 2035, 2065, and 2100 scenarios by using innovative techniques. Versar Team analyzed potential impacts of Sea Level Rise and Storm Surge by performing modeling various scenarios and events for the team. To do this, Versar coordinated the collection of various datasets from the installation as well as local, state, and federal organizations and analyzed the data for accuracy and usefulness. Versar also led a team in the field to identify the extent of high tide water levels to verify the models used to fill data gaps. The primary data gap was the lack of a permanent tidal gauge. Versar used this **innovative technique to overcome this obstacle**. Several months later, the Depot's Installation Restoration Program required a temporary tidal gauge. Data obtained from the temporary tidal gauge confirmed the success of the earlier fieldwork.

SUMMARY OF ACCOMPLISHMENT

Our primary project objective was critical installation training resilience. We focused adaptation measures on areas based on impact to mission, key benefits, and the magnitude of benefits. By combining several solutions to address one key problem area, the team applied an innovative solution to optimize the overall benefit of the corrective action.

The development process began with Stage I: Describe and Characterize the Impacts occurring now and identifying potential future climate impacts on mission-essential facilities, training areas, and roads. The first Stakeholder Workshop was held the week of July 15, 2019 and resulted in two problem statements:

- Given the potential **temporary flooding** of Field Training, Firing Ranges, and Mission-Essential Facilities and Roads, and associated MCRD PI mission impacts due to ***storm surge***, what adaptation measures can be taken to ensure recruit training can continue through 2065?
- Given the potential **permanent inundation** of Field Training, Firing Ranges, and Mission-Essential Facilities and Roads, and associated MCRD PI mission impacts due to ***sea level rise***, what adaptation measures can be taken to ensure recruit training can continue through 2065?

Stage II engaged stakeholders with Identifying Potential Action Alternatives that would address the Problem Statements identified in Stage I during the second Workshop held February 25-26, 2020. These alternatives addressed the statements while evaluating the following steps:

- Step 1: Identify potential suitable adaptation action alternatives
- Step 2: Identify the benefits and limitations of each action alternative
- Step 3: Evaluate the feasibility of the action alternatives
- Step 4: Evaluate the appropriateness of the action alternatives
- Step 5: Characterize the strategic approach to decisions under uncertainty

This evaluation resulted in 22 potential solutions to the sea level rise and storm surge impact problem statements identified in Stage I. Further discussions between the team members resulted in a re-grouping of the alternatives resulting in ten action alternatives identified as most critical in protecting the human health and the environment that were further combined into seven projects. Table below shows action alternatives and installation locations impacted.

Table 1: Project Action Alternatives/Constituent Elements and implementation Locations.

Priority Action Alternatives/ Constituent Elements	Project 1: Stormwater system upgrades	Project 2: Battalion Training Facilities Upgrades	Project 3: Road Network Upgrades	Project 4: Tidal Exclusion Barrier	Project 5: Page Field Training Facilities Relocate and Reforest	Project 6: Northern Page Field Training Facilities Relocate and Reforest	Project 7: Multiple Lines of Defense
Stormwater System Upgrades: Gray and Green Infrastructure							
Main Campus							
Page Field							
Page Field - North							
B- Battalion Training Facilities							
Main Campus							
Field Training District							
C-Road Network Upgrades							
Main Campus							
Page Field							
Page Field - North							
D – Tidal Exclusion Barrier							
Main Campus							
Page Field							
Page Field - North							
E-Page Field Training Facilities Relocations and Reforestations							
Page Field							
F- Enhanced Natural Buffers							

The following sustainable practice ideas were integrated into planning:

- Natural Infrastructure Management adaptation strategies identified in the plan are nature-based solutions for enhancement of natural buffers including green infrastructure, living shorelines, oyster reef, oyster rake, marsh and forest protection and enhancement which addresses heat index concerns, as well as immediate and future flooding concerns.
- Reduction of Water and Energy Use due to the use of native plantings and reduction of unnecessary road surfaces and runways, reducing the heat signature of the island and reducing the number of black flags days impacting training.

Stage III of the development process focused on the monetized and non-monetized benefits of each project, life cycle costs, and conducted Benefit Cost Analysis (BCA) for the projects identified within Stage II. The steps of this stage include:

- Step 1: Gather and assess physical performance metrics and life cycle costs
- Step 2: Conduct preliminary economic screening
- Step 3: Complete impact analysis framing
- Step 4: Select benefits monetization and action alternatives costing tools
- Step 5: Determine benefits to be monetized and perform calculations

The BCA shows the cumulative present value of the capital costs, operations and maintenance costs, and resiliency and environmental benefits. One of the products of this project was a set of Microsoft Excel spreadsheets for each project, asset management. Planners can adjust the timelines on the spreadsheet to recalculate capital and operation and maintenance costs.

Stage IV compiled the action alternatives into a Portfolio Summary and identifies potential variables. The steps of this stage include:

- Step 1: Assemble the Portfolio Summary
- Step 2: Identify key future variables
- Step 3: Re-evaluate a strategic approach to decisions under uncertainty
- Step 4: Characterize the risk approach
- Step 5: Relate results to the Base Master Plan Updates

The protection of human health and the environment while supporting long-term operational sustainability is the overall objective of this project. The largest resiliency benefits are obtained from delaying permanent flooding due to sea level rise of training facilities and the roads to access these facilities, which would allow MCRD PI to continue its mission. The summary benefit cost analysis results are detailed in the following table:

Table 3: Overview of Benefit Cost Analysis Results

<i>CCAR Project</i>	<i>Life Cycle Costs</i>	<i>Benefits (discounted at 7%)</i>	<i>Net Benefits (NPV)</i>	<i>Benefit Cost Ratio</i>

	<i>(discounted at 7%)</i>			
1: Stormwater System Upgrades	\$101,496,174	\$24,671,943	(\$76,824,230)	0.24
2: Battalion Training Facilities Upgrades	\$65,263,570	\$36,016,863	(\$29,246,707)	0.55
3: Road Network Upgrades	\$49,521,927	\$174,059,356	\$124,537,429	3.51
4: Tidal Exclusion Barrier	\$172,160,872	\$820,394,662	\$648,233,789	4.77
5: Page Field Training Facilities Relocate and Reforest	\$117,291,719	\$47,799,171	(\$69,492,548)	0.41
6: Northern Page Field Training Facilities Relocate and Reforest	\$73,378,591	\$56,312,192	(\$17,066,400)	0.77
7: Multiple Lines of Defense – All Elements that Protect Main Campus and Page Field North	\$160,290,918	\$834,737,757	\$674,446,839	5.21

Key: CCAR = Climate Change Adaptation and Resiliency; NPV = net present value

As a component of net benefits, the following environmental benefits were also identified:

Table 4: Project Environmental Benefits (Cumulative Present Value of 2020-2070 Benefit Stream, Based on 7 Percent Discount Rate, in 2020 Dollars)

Project	Wetlands	Forest	Total Environmental Benefits
5: Page Field Training Facilities Relocate and Reforest	\$5,153,006	\$552,209	\$5,705,216
6: Northern Page Field Training Facilities Relocate and Reforest	\$13,940,405	\$277,831	\$14,218,236
7: Multiple Lines of Defense	\$14,028,997	\$277,831	\$14,306,828

The resulting CCAR portfolio is a baseline assessment that provides the installation with data regarding how climate change is currently affecting the mission and also gives planners a tool to develop a strategy to mitigate risks in order to preserve the future of the mission.

Finally, while the portfolio is specific to MCRD PI, other entities are applying our study findings to their installations.

- 1) **Enterprise-wide**, this first formal handbook implementation conducted by NAVFAC has already informed two new implementations. The US Naval Academy is now using CCAR as a model for updating their planning data and Marine Corps Air Station (MCAS) Beaufort, SC is wrapping up a Sea Level Rise/Storm Surge modeling Task Order and began to vet adaptation alternatives. Lessons learned during the MCRD PI CCAR process are also informing NAVFAC in evaluating how **Handbook training** could evolve to support the Navy and USMC.
- 2) **Externally**: the Leidos Team and NAVFAC Mid-Atlantic Manager spoke at the Society of Military Engineers (SAME) conference in December 2019. The National American Planning Association conference approved a proposal to present CCAR – Pre-COVID.
- 3) **Regionally**, the MCRD PI deliverable will inform and enhance regional Joint Land Use Studies. Interactions within the Lowcountry community designed to increase cross-sectoral collaboration, regional planning efforts, and public/private partnerships will benefit the DoD and the region in addressing solutions for climate impacts. MCRD PI, along with MCAS Beaufort and the **Lowcountry Council of Governments, formed a partnership and have obtained a \$467,000 grant via the Office of Economic Adjustment (OEA) in FY21** to continue to address issues affecting the local community and DoD installations due to climate change.
- 4) **Locally**, the Sea Level Rise and Storm Surge modeling for MCRD PI has direct benefits to the mission of **nearby MCAS Beaufort, the new home of U.S. Marine Corps F-35B** pilot training. It is informing their work to address potential vulnerabilities to readiness (e.g., design & construction of **DLA F-35 Fuel Pier**).

Integrating the CCAR Team findings into the updated Base Master Plan ensures the program impacts and solutions are useful in protecting our mission of “We Make Marines”. The portfolio summary provides valuable detailed information for installation planners; but implementation is required to ensure installation mission resilience. **CCAR Workshops included NAVFAC Design Managers (plus AE firms) for active range projects scheduled for the next several years.** The MCRD PI team will continue to refine CCAR adaptation actions; all CCAR projects and requirements are included in the 2020 MCRD PI Installation Master Plan. **Funded projects at MCRD PI are already incorporating CCAR Sea Level Rise data into design for elevation projections, such as the Visitor Control Center (UMC project) near the Main Gate and Building M9.**